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[Description] TITLE OF THE INVENTION

METHOD AND APPARATUS FOR DETECTING [THE] POSITION OR [THE] SURFACE STRUCTURE OF AN OBJECT [, AND APPLICATION OF THE METHOD AS WELL AS A MACHINE FOR PROCESSING OBJECTS]

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and hereby claims priority to German Application No. 19938062.7 filed on August 12, 1999, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] The invention relates to a method for detecting the position or the surface structure of an object, an image of the object being generated. The invention also relates to the use of the method.

[0003] Machine tools, in particular automatic component mounting machines, place stringent requirements on accuracy during the detection, handling and processing of workpieces or components. An important problem in this is inaccuracies in the provision of the workpieces/components, which arise, for example, from a necessary play between the component and component support. These inaccuracies are generally larger than the required maximum final inaccuracy, and must therefore be corrected in the course of being processed. In particular, in addition to determining the position of the workpiece or component, it is desirable to detect whether it is damaged on the outside and must therefore be excluded straight away from further processing.

[0004] Methods for detecting workpieces/components are known which scan the latter optically and compose a corresponding two-dimensional image containing information from the third dimension (depth information). The optical sensors required for this purpose are complicated and expensive to produce. Because of their complicated design, they are difficult to integrate and can therefore be arranged only at specific stations in the processing cycle from the provision of the component up to final placement.

[0005] Consequently, these known methods are typified by subsequent correction, for example of the position of the component, or the rejection of the component as scrap. This procedure leads to not inconsiderable time losses, particularly in the case of automatic component mounting machines. Furthermore, the optical scanning of the workpieces delivers a two-dimensional image with a plenitude of information from the third dimension as well, which is not needed at all in most cases. What is important in essence is to check the position of a workpiece. Moreover, in the case of automatic component mounting machines it is necessary to inspect those parts of the component that later come to lie in the plane of the printed circuit board. An example of this would be the detection of a bent terminal pin of an electric component.

[0006] Moreover, capacitive fingerprint sensors are known which, by scanning the surface of a finger, generate an image of the fingerprint that can be used to identify a person. These sensors are easy and inexpensive to produce with the aid of silicon technology and can be integrated, in addition. Such sensors are disclosed, for example, in U.S. Patent No. 4,353,056.

SUMMARY OF THE INVENTION

[0007] It is the object of the present invention to provide a method for detecting the position or the surface structure of an object in the case of which a sensor that can be produced easily and inexpensively is used to generate an image of the object that for the most part contains only the relevant information. [This object is achieved according to the invention by a method as claimed in claim 1. Advantageous refinements of the invention and applications of the invention as well as a machine that uses the invention are to be gathered from the further claims.]

[0008] The invention specifies a method for detecting the position or the surface structure of an object, the object being placed on or right over an array of capacitive individual sensors. The lateral extent of the individual sensors may in this case be at most half the lateral extent of the object to be detected. At least one of the capacitive individual sensors experiences a capacitive disturbance at its surface through the presence of the object. This disturbance of one or more individual sensors is evaluated electronically and processed to form an image of the object.

[0009] As a result of the placement according to the invention of an object on or right over an array of capacitive individual sensors, the image, delivered by the array, of the object contains only a small amount of depth information on the parts of the object that are located near the sensor. The point is that with increasing distance from the capacitive sensor the capacitive

disturbance becomes so slight that it can be detected only weakly, or even no longer. Furthermore, disturbances in the image processing owing to lighting problems or inhomogeneous backgrounds are eliminated. The components near the sensor emerge clearly in the image, while elements further removed which therefore are also situated outside the plane of the printed circuit board, for example, appear less clearly or not at all. In addition, in the simplest case a capacitive sensor is an arrangement of individual capacitors that can be realized easily and cost-effectively.

[0010] It is particularly advantageous to use a capacitive fingerprint sensor based on a semiconductor as the array of capacitive individual sensors. In this case, the capacitive individual sensors are field effect transistors. Such a sensor can be produced cost-effectively and in an integrated fashion using the means of silicon technology.

[0011] The method according to the invention is suitable, in particular, for applications in which the surface structure or position of a mechanical workpiece or an electric component as object is detected. Particularly in the case of electric components, the method according to the invention is suitable for detecting the position and the orientation of terminal pins, since here there is a need only for the information on the plane of the printed circuit board provided for the component.

[0012] The method according to the invention is particularly well suited for application in automatic component mounting machines that have a machine tool and a component provider. The fingerprint sensors, which can easily be integrated, can be mounted straight away at the component provider or in the machine tool. This renders it possible to check the position and the orientation of terminal pins of electric components at the very beginning of the processing cycle, such that it is possible to dispense with subsequent corrections. In addition, it is possible thereby to exclude defective components, for example those with broken off or bent terminal pins, at once without unnecessarily losing cycle time for a defective component.

[0013] If appropriate, it is also possible to integrate in the automatic component mounting machines further similar or different sensors, for example for detecting the surface structure of the front and rear sides or for simultaneously detecting position and surface structure.

[0014] The invention also specifies a machine for processing objects which has a tool for providing the objects and a tool for transporting the objects. Integrated in one or both tools is an

array of capacitive individual sensors that detects the position and/or the surface structure of the objects in accordance with the method described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] [The] These and other objects and advantages of the present invention [is] are explained in more detail below with the aid of an exemplary embodiment and the associated figures, in which:

Figure 1 [shows] is a plan view of an object that is placed according to the invention over a fingerprint sensor, and

Figure 2 [shows] is a cross section of the object of Figure 1 placed over a fingerprint sensor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0017] Figure 1 shows an electric component 3 with terminal pins 4, which is positioned over a sensor array 1. The sensor array 1 consists of a plurality of capacitive individual sensors 2. The lateral extent of the capacitive individual sensors 2 is substantially smaller than the lateral extent of electric component 3. This ensures that an image of the electric component 3 of adequate resolution is produced.

[0018] Figure 2 shows an electric component 3 with terminal pins 4 that is arranged right next to a sensor array 1. The sensor array 1 consists of capacitive individual sensors 2. Connected to the sensor array is an electronic evaluation system 5 with downstream image processing 6. When applied to the detection of the orientation of terminal pins of electric components, the method according to the invention can be used, for example, to detect the bent away terminal pin illustrated at the bottom in Figure 2 and to exclude the electric component 3 from the further processing cycle as scrap.

[0019] The invention [is not restricted to the special embodiments shown by way of example, but is defined in its most general form by claim 1] has been described in detail with particular reference to preferred embodiments thereof and examples, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.